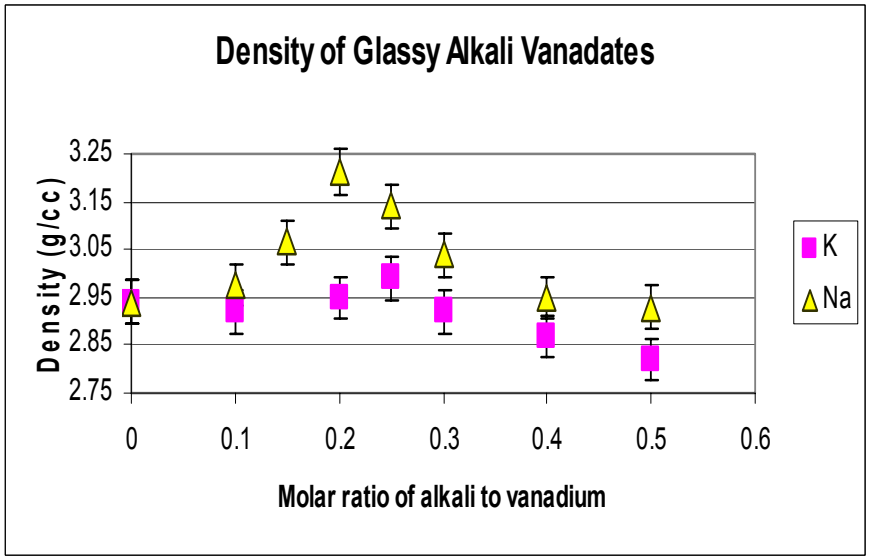
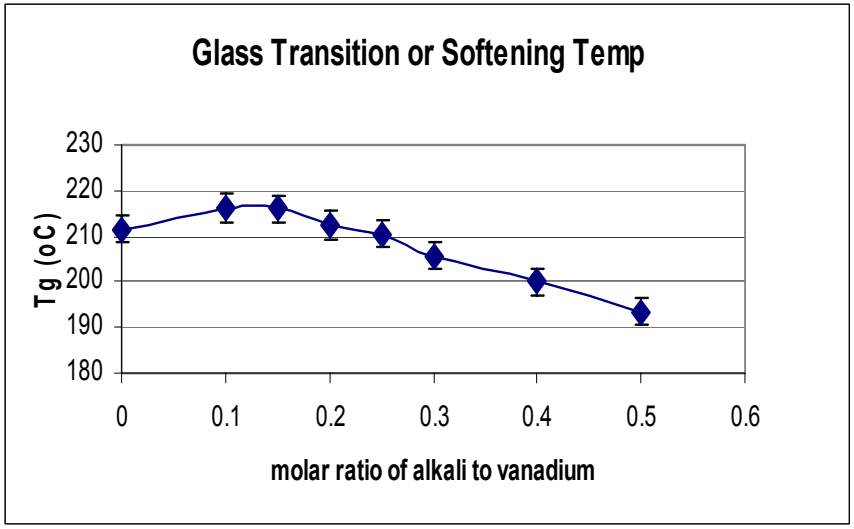
Physical Properties and Spectroscopy of Glasses Related Intermediate Range Order, Steve Feller and Mario Affatigato, *Coe College*, Award #0211718

We have continued a study of newly found alkali vanadate glasses. The top plot depicts the density of three alkali vanadate systems as a function of alkali content. Note the anomalous maxima near the ratio of alkali to vanadium of about 0.2. At a slightly lower ratio there is also a maximum in the glass transition or softening temperature. We think these data are due to an unreported coordination change within this system. A recent V-51 NMR study confirms a structural change for this ratio.





Vanadium pentoxide and alkali oxide vanadium pentoxide compounds will form glasses if rapidly cooled in a twin roller device. These glasses have similar compositions to the well known phosphate glasses. However vanadium-based glasses tend to be electrically conducting, a potentially very useful property. Also, these glasses are much more resistant to water attack then the phosphates. We are first trying to characterize these glasses by the compositions that form glass as well as making the first measurements of the physical properties and structure of these materials. We have found strong evidence for a significant structural modification in the glass at about 15 to 20 molar percent alkali oxide. As maybe imagined this discovery is highly motivating to undergraduate researchers and their faculty as well!

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Education: During the past 3 summers more than 20 undergraduates have participated in this research including 4 REU students from colleges in Wisconsin, Michigan, and Iowa. These students from Coe have gone to high quality graduate schools including Stanford Univ, Johns Hopkins, Georgia Tech, Univ.of Missouri Rolla, Harvard, and others. Also, our students have done collaborative research at the Univ. of Reading (UK) for neutron scattering, University of Manitoba for high field solid state NMR, University of Warwick (UK) for novel pulsed ^{10}B NMR experiments, Fudan Univ (China) for non-linear optics and Sojo Univ (Japan) for novel prep techniques.

Outreach: Students and faculty participated in a raft of outreach programs including making glass with students at two middle school student conferences in Cedar Rapids, working with students at local schools and performing physics demonstrations for 450 students and parents at an open house.

Our undergraduate research program is extremely active. Since its inception more than 140 students have participated in it. It started as a basic research project into the structure and some properties of oxide glasses. But we have expanded it greatly to include optical characterization and other properties and we have added much instrumentation to it. Thus, in the past few years we have added a modern laser time-of-flight mass spectrometer, Raman spectroscopy, X-ray flourescence, and atomic force microscopy. The program attracts significant student participation each summer with approximately 18-20 students working with us. Also, we have extensive collaborations that work well (see above for some current examples). Last summer 8 students studied in such labs. We have published about 100 papers with our students in the standard literature of the field and we routinely give talks (both students and faculty at professional meetings here and abroad. We average about 8-10 talks per year now.

We have begun giving talks about how we work with students, a program that extends over 4 years at the undergraduate level. This is most unusual and colleagues seem to be interested in how we do this. Also, we are part of an NSF REU site. Our support is also provided by DMR and by the international division of NSF for research in China and Japan.

This experience is highly motivating to students to further their education and about 75% of our students move on to graduate school in a plethora of research areas.

Our students and us are eager to spread the word to the general public about our research and other aspects of physics. They frequently give tours, and we bring glassmaking out to the community. We think it is a win-win situation for students to do this. They are our best recruiters of future science students.